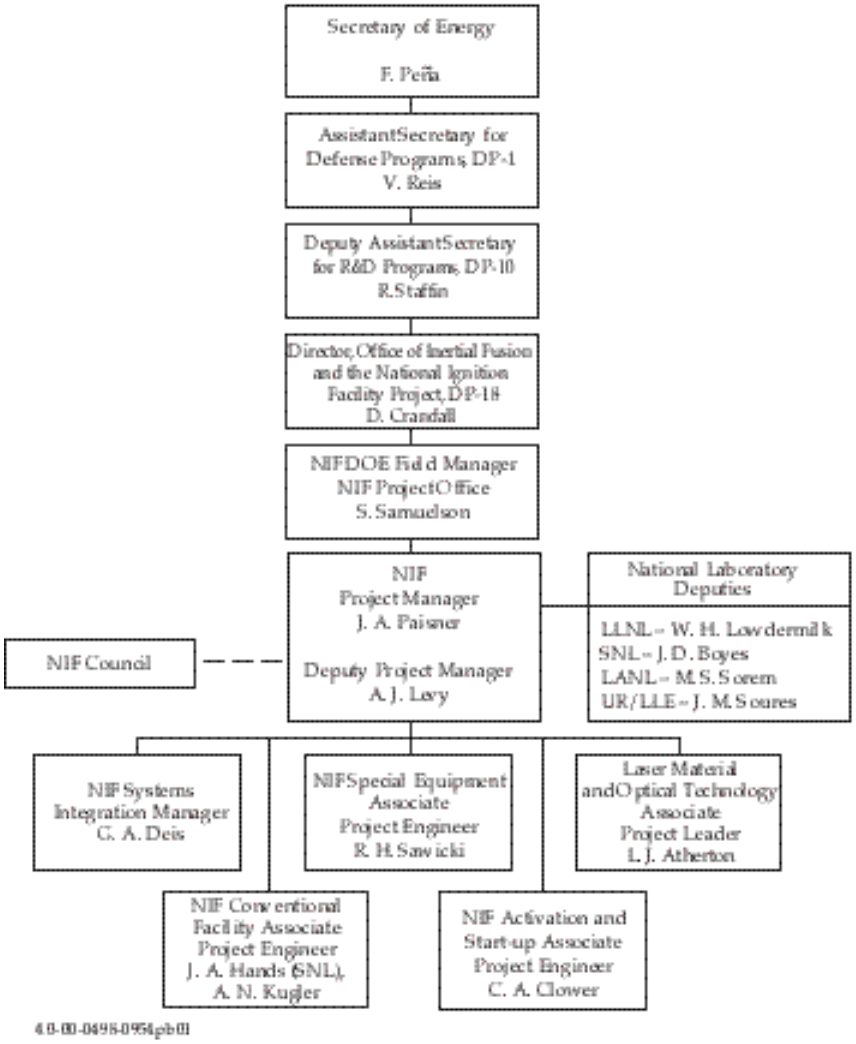
PREFACE

The National Ignition Facility Project

The mission of the National Ignition Facility (NIF) is to produce ignition and modest energy gain in inertial confinement fusion (ICF) targets. Achieving these goals will maintain U.S. world leadership in ICF and will directly benefit the U.S. Department of Energy (DOE) missions in national security, science and technology, energy resources, and industrial competitiveness. Development and operation of the NIF are consistent with DOE goals for environmental quality, openness to the community, and nuclear nonproliferation and arms control. Although the primary mission of inertial fusion is for defense applications, inertial fusion research will provide critical information for the development of inertial fusion energy.

The NIF, under construction at Lawrence Livermore National Laboratory (LLNL), is a cornerstone of the DOE's science-based Stockpile Stewardship Program for addressing high-energy-density physics issues in the absence of nuclear weapons testing. In pursuit of this mission, the DOE's Defense Programs has developed a state-of-the-art capability with the NIF to investigate high-energy-density physics in the laboratory with a microfusion capability for defense and energy applications. As a Strategic System Acquisition, the NIF Project has a separate and disciplined reporting chain to DOE as shown below.



The NIF is the largest and most complex laser project of its kind and the most challenging laser–target interaction system ever constructed. With a primary requirement to deliver 1.8 megajoules of ultraviolet laser energy at a peak power of 500 terawatts, the NIF will exceed the Nova laser at LLNL and the Omega laser at the University of Rochester's Laboratory for Laser Energetics (UR/LLE), currently the world's largest ICF experimental tools, by factors of 40 in energy and over 10 in peak power.

At the time of publication of this *Quarterly Report*, the NIF Project has progressed beyond the Title I design reported here. The NIF Project completed its Title I design in October of 1996. By the end of FY 1997, NIF Project management and staff positions were filled to planned levels. An engineering and support team with almost 400 members drawn from LLNL, Sandia National Laboratories, Los Alamos National Laboratory, and UR/LLE was approximately halfway through Title II (final) design, with nearly 90% of all requirements and interfaces under configuration control. NIF structural design reached 100% levels in many areas, and by year's end excavation was almost complete, with concrete being poured. Five of the eight Conventional Facilities construction packages were awarded for site preparation, site excavation, target building mat, laser bay foundations, laser building shell, and the Optics Assembly Building. The NIF will occupy a building that is 704 feet long, 403 feet wide, and 85 feet tall, about the size of a football stadium. The NIF is twice as tall, long, and wide as LLNL's Nova facility. Major project facilitization contracts were placed with commercial vendors (i.e., for finishing of flats, mirrors, lenses, laser slabs, potassium di-hydrogen phosphate [KDP] crystals, and fused silica production) to ensure an adequate optics production capability that meets the NIF cost goals. The NIF laser will contain 33,000 square feet (three-quarters of an acre) of highly polished precision optics, such as glass laser-amplifier slabs, lenses, mirrors, and crystals. This is more than 40 times the total precision-optic surface area in the Keck telescope, the largest telescope in the world. In fact, the NIF will contain more precision optics than all the telescopes in the world put together.

Concurrent with technology development activities, the documents that provide a hierarchy of the NIF design requirements were reviewed and updated, including *System Design Requirements* and the laser system design/performance baseline. Project controls developed and implemented last year, including the *NIF Project Control Manual*, the *Configuration Management Plan*, the *Integrated Project Schedule*, *Cost Account Plans*, and the DOE-approved *Quality Assurance Plan*, were utilized throughout this year. The NIF Project underwent a full DOE Safety Management Evaluation late in the year and was judged to be a model project.

The NIF Project continues to be on schedule and on budget, and its staff is confident in its commitment to meet all of the NIF's requirements. For details on the progress of NIF construction see http://lasers.llnl.gov/lasers/nif/building.

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NIF Project Manager

FOREWORD

This special issue of the *ICF Quarterly Report* summarizes the engineering design of the National Ignition Facility (NIF) at the end of the Title I or preliminary design phase, as defined in the box on p. vi. These articles are based upon design review presentations held in October and November, 1996, as presented by an integrated project team from Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Sandia National Laboratories, and the University of Rochester Laboratory for Laser Energetics. A Title I design review committee composed of senior personnel from inside and outside the project evaluated these presentations and reported to Project Management and the Department of Energy (DOE) that the project was ready to proceed to the Title II or definitive design phase. At the same time, a DOE Independent Cost Estimate review team concluded that the cost estimates prepared for Title I were reasonable. The DOE authorized the start of Title II design in December 1996.

The major features of the NIF are frozen and will be constructed according to the designs outlined in the following articles. There will continue to be minor changes and improvements during Title II as various design and cost issues are analyzed in detail, but these will have minor effects on the appearance and performance of the facility as presented here.

The design description starts with a brief introduction, *A Walk Through the National Ignition Facility*, and an overview of the NIF laser requirements and performance. The NIF will require about an order of magnitude more high-quality optical components than any facility yet constructed, so the discussion of the laser system design has a heavy emphasis on the design and procurement strategy for these optics. The electrical, mechanical, and structural designs of the most important laser components and the target area are then presented, followed by a discussion of the laser control systems. This issue also summarizes the strategies for transporting and handling the various optical components, and the design of the NIF's Conventional Facilities (buildings and utilities).

The environment, safety, and health (ES&H) issues of the NIF Title I design are not included in these descriptions. A thorough discussion of the health and safety aspects of NIF can be found in the *National Ignition Facility Preliminary Safety Analysis Report*, LLNL document UCRL-ID-123759 (September 1996), available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161. Environmental issues are discussed in the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, Volume III, U.S. DOE document DOE/EIS-0236 (September 1996), available from the Office of Technical and Environmental Support, DP-45, U.S. DOE, 1000 Independence Avenue SW, Washington, DC 20585.

Current information about the NIF Project can be found on the World Wide Web at http://lasers.llnl.gov/nif.html.

John Murray
Scientific Editor

OFFICIAL STAGES OF A MAJOR DOE CONSTRUCTION PROJECT

Conceptual Design

Conceptual design includes activities required to evaluate project design alternatives and to develop sufficient detail to baseline the scope, cost, and schedule in preparation for a decision to authorize the project. The NIF conceptual design was completed in 1994 and is documented in *National Ignition Facility Conceptual Design Report,* UCRL-PROP-117093 (May 1994), available from the National Technical Information Service, 5285 Port Royal Rd., Springfield, VA 22161.

Title I Design

The Title I or "preliminary" design phase further develops the conceptual design to include engineering studies and analyses, risks, preliminary drawings and engineering specifications, cost and schedule estimates, and life-cycle cost estimates. Typically Title I will consume roughly a quarter to a third of the engineering effort for the project.

Title II Design

Following approval of the Title I design by DOE, the Title II or "definitive" design phase covers the preparation of final working drawings, specifications, bidding documents, and firm construction and procurement schedules. At the end of Title II, construction and procurement contracts will be released to vendors for bid.

Title III Activities

Title III activities cover the receipt, inspection, assembly, and test of the project facilities and hardware, as well as any changes that are required during construction or assembly. Final as-built drawings, manuals, and other documentation of the facility are also prepared as part of Title III. At the end of Title III the project is ready for activation and operation by the operations staff.

For further details, see Series 400 (DOE Order 430.1) at
http://www.explorer.doe.gov:1776/htmls/regs/doc/newserieslist.html